VERIFICATION OF TRANSLATION

US Patent Application No. 10/001709

Filing Date: 23 October 2001

Title of the Invention: POLARINZING PLATE AND LIQUID CRYSTAL DISPLAY USING THE SAME

I, Reiko TOTANI, whose full post office address is IKEUCHI • SATO & PARTNER PATENT ATTORNEYS, 26TH Floor, OAP TOWER, 8-30, Tenmabashi 1-chome, Kita-ku, Osaka-shi, Osaka 530-6026, JAPAN, am the translator of the documents attached and I state that the following are true translations to the best of my knowledge and belief of JP11-064631 (Date of Application: 13 August 1997).

At Osaka, Japan

Dated this 2 August 2006 (Day/Month/Year)

Signature of translator:

Reiko Totani

Reiko TOTANI

[Translation Japanese → English of JP H11-064631A]

(19) Japanese Patent Office (JP)

(12) Patent Gazette (A)

(11) Patent Appl. Publ. Number H11-064631

(43) Date of Publication: March 5, 1999

(51) Int. Cl.[6]		ID Number	FI		
G 02 B	5/30		G 02 B	5/30	
G 02 F	1/1355	515	G 02 F	1/1335	515
G 09 F	9/35	321	G 09 F	9/35	321

Request for Examination: not yet filed Number of Claims: 10 (9 pages in total)

(21) Appl. Number: H09-218536

(22) Appl. Date: August 13, 1997

(71) Applicant: 000002369
Seiko Epson Corporation
2-4-1 Nishi-Shinjuku, Shinjuku-ku, Tokyo

(72) Inventor: Osamu OKUMURA
c/o Seiko Epson Corporation.
3-3-5 Owa, Suwa, Nagano

(74) Representative: Patent Attorney
Kisaburo SUZUKI; (others: 02)

(54) [Title of the Invention] Polarizing means, liquid crystal device and electronic device

(57) [Abstract]

[Problem] Provided are a bright polarizing means with a high polarization degree, a bright liquid crystal device with a high contrast and an electronic device with low power consumption.

[Solving means] A polarizing means comprising a plurality of reflective polarizers that are laminated on one another with their polarization axes being aligned, wherein the reflective polarizers respectively reflect

predetermined linearly polarized light components in different wavelength ranges, and transmit the remainder of light. Furthermore, the reflective polarizers each comprise a plurality of layers in which a birefringent substance and an isotropic substance are laminated alternately.

[Claims]

[Claim 1] A polarizing means comprising a plurality of reflective polarizers that are laminated on one another with their polarization axes being aligned, wherein the reflective polarizers respectively reflect predetermined linearly polarized light components in different wavelength ranges, and transmit the remainder of light.

[Claim 2] The polarizing means according to claim 1, wherein the reflective polarizer comprises a plurality of layers in which a birefringent substance and an isotropic substance are laminated alternately.

[Claim 3] The polarizing means according to claim 1 or 2, wherein a reflection wavelength range of each of the reflective polarizers overlaps a reflection wavelength range of one of the reflective polarizers other than itself.

[Claim 4] The polarizing means according to any one of claims 1 to 3, wherein the polarizing means is constituted by three reflective polarizers, and the reflective polarizers mainly reflect polarized light of blue, green and red wavelengths, respectively.

[Claim 5] The polarizing means according to any one of claims 1 to 4, wherein at least one of the reflective polarizers constituting the polarizing means reflects polarized light in a near-ultraviolet region.

[Claim 6] The polarizing means according to any one of claims 1 to 5, wherein the reflective polarizers are laminated in the order of increasing reflection wavelength from a light incident side.

[Claim 7] The polarizing means according to claim 6, wherein a light absorbing member is provided adjacent to the reflective polarizing plates.

[Claim 8] The polarizing means according to claim 6 or 7, wherein a light scattering member is provided adjacent to the polarizing means.

[Claim 9] A liquid crystal device comprising: a polarizing plate that absorbs at least a predetermined linearly polarized light component and transmits the remaining polarized light components; a liquid crystal cell comprising a pair of substrates including a transparent electrode and a liquid crystal composition sandwiched between the substrates; and the polarizing means according to any of claims 1 to 8, wherein the polarizing plate, the liquid crystal cell and the polarizing means are arranged in this order.

[Claim 10] An electronic device comprising the liquid crystal device according to claim 9 as a display portion.

[Detailed description of the Invention]
[0001]
[Technical field to which the Invention pertains]
The present invention relates to a polarizing means, also relates to a liquid crystal device using this polarizing means, and also relates to an electronic device equipped with this liquid crystal device.
[0002]
[Prior Art]

Reflective liquid crystal devices, semitransparent reflective liquid crystal devices and the like that have low power consumption are suitable for applications in information tools such as PDAs and portable electronic devices such as mobile phones and watches. However, conventional reflective liquid crystal devices and semi-reflective liquid crystal devices had the problem that their display was dark.

[0003]

For example, unexamined International Application (International Application No. WO97/01788) and JP H9-506985A disclose a method in which a polarizing means using a birefringent dielectric multilayer film is utilized as a means for solving such a problem.

[0004]

This birefringent dielectric multilayer film has a function of reflecting a predetermined linearly polarized light component, and transmitting other polarized light components. Such a polarizing means is characterized in that it is very bright, since it totally reflects a predetermined polarized light component unlike a reflective metal plate, and it does not absorb light, unlike an absorptive polarizing plate.

[0005]

[Problems that the Invention is to solve]

However, such polarizing means using the conventional birefringent dielectric multilayer film also had the problems of a low polarization degree and a great color change depending on the viewing angle. Conventional liquid crystal devices using this polarizing means had a problem of not being capable of achieving contrast.

[0006]

Therefore, it is an object of the present invention to provide a bright polarizing means with a high polarization degree. It is also an object of this invention to provide a bright liquid crystal device with a high contrast, and an electronic device with low power consumption.

[0007]

[Means for solving the problem]

The polarizing means described in claim 1 is a polarizing means including a plurality of reflective polarizers that are laminated on one another with their polarization axes being aligned, wherein the reflective polarizers respectively reflect predetermined linearly polarized light components in different wavelength ranges, and transmit the remainder of light. Due to this configuration, the polarizing means described in claim 1 can provide polarized light with a high polarization degree over a wide wavelength range. Furthermore, by aligning the axes, the birefringence of each of the reflective polarizers do not affect the polarization degrees of the remaining reflective polarizers. The axes are parallel at least within 1°, preferably within 0.5°.

[0008]

The polarizing means described in claim 2 is the polarizing means according to claim 1, wherein the reflective polarizer includes a plurality of layers in which a birefringent substance and an isotropic substance are laminated alternately. Due to this configuration, the polarizing means described in claim 2 can have a high reflectance for a predetermined polarized light component, without absorbing light.

[0009]

The polarizing means described in claim 3 is the polarizing means according to claim 1 or 2, wherein a reflection wavelength range of each of the reflective polarizers overlaps a reflection wavelength range of one of the reflective polarizers other than itself. Due to this configuration, the polarizing means described in claim 3 can provide polarized light that has a uniform polarization degree in a visible light range and less coloration depending on the viewing angle direction.

[0010]

The polarizing means described in claim 4 is the polarizing means according to any one of claims 1 to 3, wherein the polarizing means is constituted by three reflective polarizers, and the reflective polarizers mainly reflect polarized light of blue, green and red wavelengths, respectively. Due to this configuration, the polarizing means described in claim 4 can reflect light to a color liquid crystal device efficiently.

[0011]

The polarizing means described in claim 5 is the polarizing means according to any one of claims 1 to 4, wherein at least one of the reflective polarizers constituting the polarizing means reflects polarized light in a near-ultraviolet region. However, it is assumed that reflection of near-ultraviolet light occurs when light incident from a direction substantially normal is reflected in the normal direction. It should be noted that, according to the description in the section "ultraviolet radiation" in Rikagaku Jiten, (fourth edition published in 1994 by Iwanami Shoten), "light in a near-ultraviolet region" refers to light whose minimum wavelength is 300 nm and whose maximum wavelength is 360 to 400 nm, which is the short wavelength end of visible light. In the polarizing means described in claim 5, it is particularly desirable that the polarizers reflect polarized near-ultraviolet light of at least 330 nm, and more preferably at least 350 nm and at most 400 nm. Due to this configuration, the polarizing means described in claim 5 has less coloration depending on the viewing angle direction. This effect results from the fact that the light reflected by the reflective polarizers shifts toward the long wavelength side for the light incident on the plane at a shallow angle. Accordingly, a polarizing means constituted by a reflective polarizer that reflects only light in a range that barely covers visible light is yellowish when viewed obliquely. Therefore, when a reflective polarizer that reflects light in the near-ultraviolet region is used, this reflective polarizer reflects violet to blue light when viewed obliquely, so that polarizing means has less coloration.

[0012]

The polarizing means described in claim 6 is the polarizing means according to any one of claims 1 to 5, wherein the reflective polarizers are laminated in the order of increasing reflection wavelength from a light incident side. Due to this configuration, the polarizing means described in claim 5 tends not to cause light scattering, and also can provide polarized light with a high polarization degree. Furthermore, it tends not to develop a bluish coloration.

[0013]

The polarizing means described in claim 7 is the polarizing means according to claim 6, wherein a light absorbing member is provided adjacent to the reflective polarizing plates. Due to this configuration, the polarizing means described in claim 7 can provide polarized light with a high polarization degree.

[0014]

The polarizing means described in claim 8 is the polarizing means according to claim 6 or 7, wherein a light scattering member is provided adjacent to the polarizing means. Due to this configuration, the polarizing means described in claim 8 can provide bright polarized light.

[0015]

The liquid crystal device described in claim 9 includes: a polarizing plate that absorbs at least a predetermined linearly polarized light component and transmits the remaining polarized light components; a liquid crystal cell including a pair of substrates including a transparent electrode and a liquid crystal composition sandwiched between the substrates; and the polarizing means according to any of claims 1 to 8, wherein the polarizing plate, the liquid crystal cell and the polarizing means are arranged in this order. Due to this configuration, the liquid crystal device described in claim 9 can provide a bright reflective or semitransparent reflective display with less coloration.

[0016]

The electronic device described in claim 10 includes the liquid crystal device according to claim 9 as a display portion. Due to this configuration, the electronic device described in claim 10 can obtain an easily viewable display that consumes low power.

[0017]

[Embodiments of the Invention]

Hereinafter, embodiments of the present invention are described in detail with reference to the drawings.

[0018]

(Example 1)

FIG. 1 is a diagram showing a relevant part of the structure of a polarizing means according to the invention described in claims 1 to 4 and 6 of the present invention. First, the configuration is described. In FIG. 1, 101 denotes a reflective polarizer that mainly reflects polarized blue light, 102 denotes a reflective polarizer that mainly reflects polarized green light, 103 denotes a reflective polarizer that mainly reflects polarized red light, and 104 denotes a transparent base film. 101, 102, 103 and 104 are optically bonded to one another. "Optically bonded" means that these elements are bonded using a transparent adhesive having a refractive index that is close to the refractive indices of the elements, or by performing heat lamination without using any adhesive, such that redundant surface reflection will not occur.

[0019]

TAC (triacetylcellulose) or DAC (cellulose acetate) film is suitable as the transparent base film. While the transparent base film is used for preventing tearing of the reflective polarizers and providing elasticity to the polarizing means so that it can be easily attached on the surface of the liquid crystal device, this is not an essential element of the present invention and

may be omitted. Aside from this, it is also possible to provide a transparent protective film such as TAC above 101.

[0020]

Next, the internal structure of the reflective polarizers 101, 102 and 103 is described. FIG. 2 is a diagram illustrating a relevant part of the structure of the reflective polarizers. Basically, each of the reflective polarizers is a birefringent dielectric multilayer film including two different polymer layers 201 and 202 that are laminated alternately. One of the two different polymers may be selected from materials having a large photoelasticity, and the other may be selected from materials having a small photoelasticity. At this time, care should be taken to make their refractive indices for ordinary rays substantially equal. For example, PEN (2,6-polyethylene naphthalate) may be selected as a material having a large photoelasticity, and coPEN (70-naphthalate/30-terephthalate copolyester) may be selected as a material having a small photoelasticity. When the two films were laminated alternately, and stretched to about five times their original length in the x-axis direction on a rectangular coordinate system 203 in FIG. 2, the refractive index in the x-axis direction was 1.88 in the PEN layer, and 1.64 in the coPEN layer. The refractive index in the y-axis direction was approximately 1.64 both in the PEN layer and the coPEN layer. When light is incident on this laminated film from the normal direction, light components that oscillate in the y-axis direction are transmitted through the film directly. This is a transmission axis. On the other hand, light components that oscillate in the x-axis direction are reflected only when the PEN layer and the coPEN layer satisfy a predetermined condition. This is a reflection axis. The condition is that the sum of the optical path length of the PEN layer (the product of the refractive index and the film thickness) and the optical path length of the coPEN layer (the product of the refractive index and the film thickness) is equal to one-half of the wavelength of light. By laminating several tens of layers, or if possible, several hundreds of

layers of such PEN layers and coPEN layers into a thickness of about 30 μm, it is possible to reflect substantially all the light components that oscillate in the x-axis direction.

[0021]

The ideal reflective polarizer produced in this way provides polarizance only for light of a single designed wavelength. In practice, there are variations in thickness of the PEN layers and the coPEN layers, and polarizance is therefore produced for a certain degree of wavelength range; however, this is only a range of several tens of nanometers. It is absolutely impossible to provide polarizance for the entire wavelength range of visible light.

[0022]

Therefore, in the present invention, polarizance is provided over a wide wavelength range by laminating a plurality of reflective polarizers having different polarized reflectance wavelength ranges with their axes being aligned, as shown in FIG. 1. Here, it is very important to align their axes. The reason is that the reflective polarizers have a large retardation due to their structure. The value is about 2 μm to 8 μm, which is many times the wavelength of light. Accordingly, when light is incident from above in FIG. 1, linearly polarized red light that is reflected at the lower layer 103 is undesirably converted into elliptically polarized light due to the retardation of the upper layers 101 and 102. This defeats the function of a polarizing means. Furthermore, when this is combined with a liquid crystal device, it is not possible to achieve a high contrast. Therefore, this phenomenon was obviated by arranging the axes of 101, 102 and 103 precisely parallel. It is desirable that the axes are parallel at least within 1°, and preferably within 0.5°.

[0023]

FIG. 3 is a graph showing the polarization properties of the reflective polarizers 101, 102 and 103 of FIG. 1. 301, 302 and 303 indicate the

reflection spectra of 101, 102 and 103 in the reflection axis direction, respectively, and 311, 312 and 313 indicate the reflection spectra of 101, 102 and 103 in the transmission axis direction, respectively. 101 reflects light of approximately 380 nm to 530 nm, 102 reflects light of approximately 490 nm to 600 nm, and 103 reflects light of 570 nm to 770 nm. The respective reflection wavelength ranges overlap each other by about 30 to 40 nm.

[0024]

The long wavelength end and the short wavelength end of the reflection wavelength range vary depending on the degree of variations in layer thickness among the reflective polarizers. Therefore, the reflection wavelength ranges of the reflective polarizers are caused to overlap each other, thereby making it possible to ensure a certain polarization degree over the visible light range regardless of manufacturing differences.

[0025]

When the direction of incidence of light changes, the apparent layer thickness of the reflective polarizer varies and hence the reflection wavelength range changes. However, when the reflective polarizer is produced by stretching, the refractive index in the film thickness direction tends to fluctuate by a small factor such as the temperature, the combination of materials or the stretching speed. Since the refractive index in the film thickness direction significantly affects the viewing angle properties, there is a high probability that the reflection color change depending on the viewing angle is varied depending on the reflective polarizer. Even in such a case, the reflection wavelength ranges of the reflective polarizers are caused to overlap each other, thereby making it possible to ensure a certain polarization degree over the visible light range regardless of manufacturing differences.

[0026]

The polarizing means produced in this way exhibited a high polarization degree of at least 95% over substantially the entire visible light

region. Moreover, it has a characteristic of being 30% brighter than a conventional polarizing means including an absorptive polarizing plate and an aluminum reflective plate. There are two reasons for this. One is that the reflectance of metallic aluminum is a little less than 90%, whereas the polarizing means of the present invention reflects substantially 100% of light that is parallel to the reflection axis. The other reason is that an ordinary absorptive polarizing plate uses a dichroic substance, including, for example, a halogen substance such as iodine and a dye, and its dichroic ratio may not be necessarily high, so that about 20% of the light is wasted.

[0027]

In order to show an optimum example, the three layers of reflective polarizers of blue, green and red are used and laminated in this order in Example 1. It should be appreciated that other combinations of colors, for example, reflective polarizers of purple, cyan, orange, deep red, blue, yellow and red may be used and these may be laminated in random order.

[0028]

(Example 2)

Example 2 is a polarizing means according to the invention described in claim 4 of the present invention.

[0029]

The polarizing means of Example 2 has a structure similar to that of Example 1, and includes a reflective polarizer 101 that mainly reflects polarized blue light, a reflective polarizer 102 that mainly reflects polarized green light, a reflective polarizer 103 that mainly reflects polarized red light, and a transparent base film 104, as shown in FIG. 1. As shown in FIG. 2, each of the reflective polarizers also includes a laminate of PEN layers 201 and coPEN layers 202. However, their optical path lengths are different, so that Example 2 has polarization properties different from those of Example 1.

[0030]

FIG. 4 is a graph showing the polarization properties of the reflective polarizers 101, 102 and 103 of FIG. 1. 401, 402 and 403 indicate the reflection spectra of 101, 102 and 103 in the reflection axis direction, respectively, and 411, 412 and 413 indicate the reflection spectra of 101, 102 and 103 in transmission axis direction, respectively. 101 reflects light of approximately 430 nm to 510 nm, 102 reflects light of approximately 520 nm to 580 nm, and 103 reflects light of 600 nm to 680 nm. Their reflection wavelength ranges almost do not overlap each other.

[0031]

The polarizing means produced in this way has a great effect when used for a color liquid crystal device. The reflection wavelength ranges of 401, 402 and 403 coincide with the high transmittance regions of color filters of blue, green and red of a color liquid crystal device, respectively. Accordingly, using the polarizing means of the present invention enables a vivid color display to be achieved. Furthermore, the polarizing means of the present invention is also superior to combinations of reflective polarizers of other colors such as purple, cyan and yellow in that the manufacturing differences of the reflection wavelength ranges of the reflective polarizers do not affect the brightness or color significantly. It should be appreciated that it is possible to achieve a vivid color display by using this polarizing means in combination with an STN color liquid crystal device utilizing birefringent interference, instead of using color filters.

[0032]

(Example 3)

Example 3 is a polarizing means according to the invention described in claim 5 of the present invention.

[0033]

The polarizing means of Example 3 also has a structure similar to that of Example 1, and includes a reflective polarizer 101 that mainly reflects polarized blue light, a reflective polarizer 102 that mainly reflects

polarized green light, a reflective polarizer 103 that mainly reflects polarized red light, and a transparent base film 104, as shown in FIG. 1. As shown in FIG. 2, each of the reflective polarizers also includes a laminate of PEN layers 201 and coPEN layers 202. However, their optical path lengths are different, so that Example 3 has polarization properties different from those of Example 1.

[0034]

FIG. 5 is a graph showing the polarization properties of the reflective polarizers 101, 102 and 103 of FIG. 1. 501, 502 and 503 indicate the reflection spectra of 101, 102 and 103 in the reflection axis direction, respectively, and 511, 512 and 513 indicate the reflection spectra of 101, 102 and 103 in transmission axis direction, respectively. 101 reflects light of approximately 330 nm to 500 nm, 102 reflects light of approximately 450 nm to 650 nm, and 103 reflects light of 550 nm to 790 nm. Their reflection wavelength ranges overlap each other by about 50 to 100 nm. In addition, the reflection wavelength range of 101 extends over the near-ultraviolet region.

[0035]

The polarizing means produced in this way has polarizance also for light that is incident obliquely, and is therefore characterized in that it will not develop coloration.

[0036]

In general, a polarizing means is required to have a polarizance for the entire wavelength range of visible light, except for a case where a colored display is provided intentionally. According to the description in the section "visible radiation" in Rikagaku Jiten, (fourth edition published in 1994 by Iwanami Shoten), "wavelength range of visible light " refers to light whose minimum wavelength is 360 to 400 nm and whose maximum wavelength is 760 nm to 830 nm, and a particularly important among these is the range of 400 nm to 760 nm, which is highly visible to humans.

[0037]

However, the apparent layer thickness of a reflective polarizer generally increases when light is incident thereon obliquely, so that the reflection wavelength range shifts toward the long wavelength side. Accordingly, polarizance tends to be lost for purple light near 400 nm. Therefore, by initially designing the reflective polarizer such that it has polarizance for near-ultraviolet light, the reflective polarizer can have polarizance for all the visible light incident thereon obliquely.

[0038]

For example, in order to have polarizance for light of at least 400 nm when incident from a direction inclined by 30° with respect to the normal direction, the reflective polarizer may be constructed such that it has polarizance for light of at least 380 nm in the normal direction. Likewise, the reflective polarizer may be constructed such that it has polarizance for light of at least 370 nm, light of at least 360 nm, light of at least 350 nm, light of at least 340 nm and light of at least 330 nm in the normal direction in the cases of light incident from a direction inclined by 40°, light incident from a direction inclined by 50°, light incident from a direction inclined by 60°, light incident from a direction inclined by 70°and light incident from a direction inclined by 80° with respect to the normal direction, respectively.

[0039]

For light inclined 80° with respect to the normal direction, the spectra of 501, 502 and 503 shown in FIG. 5 shift to the wavelength range of 400 nm to 600 nm, the wavelength range of 540 nm to 790 nm and the wavelength range of 670 nm to 960 nm, respectively, but they still cover substantially the entire wavelength range of visible light. Accordingly, no coloration occurs.

[0040]

(Example 4)

FIG. 6 is a diagram showing the structure of a polarizing means according to the invention described in claim 6 of the present invention, and illustrating its function. First, the configuration is described. In FIG. 6, 601 denotes a reflective polarizer that mainly reflects polarized blue light, 602 denotes a reflective polarizer that mainly reflects polarized green light, 603 denotes a reflective polarizer that mainly reflects polarized yellow light, and 604 denotes a reflective polarizer that mainly reflects polarized red light. 601, 602, 603 and 604 are optically bonded to each other with an adhesive 605. Each of the reflective polarizers includes a laminate of PEN layers 201 and coPEN layers 202, as shown in FIG. 2.

[0041]

FIG. 7 is a graph showing the polarization properties of the reflective polarizers 601, 602, 603 and 604 of FIG. 6. 701, 702, 703 and 704 indicate the reflection spectra of 601, 602, 603 and 604 in the reflection axis direction, respectively, and 711, 712, 713, 714 indicate the reflection spectra of 601, 602, 603 and 604 in the transmission axis direction, respectively. 601 reflects light of approximately 380 nm to 500 nm, 602 reflects light of approximately 490 nm to 600 nm, 603 reflects light of approximately 550 nm to 660 nm, and 604 reflects light of 610 nm to 780 nm. The respective reflection wavelength ranges overlap each other by about 10 to 50 nm.

[0042]

The polarizing means of Example 4 is characterized in that the layers are laminated in the order of the reflection wavelengths so that the reflection wavelength is shortest on the light incidence side. Due to this configuration, it was possible to provide polarized light that is not prone to light scattering and also has a high polarization degree. Furthermore, it tends not to develop bluish coloration. This effect is caused by two factors.

[0043]

One is an influence of the retardation of the reflective polarizer itself. Due to its structure, a reflective polarizer always has retardation; however,

when there is even a slight misalignment in the axes of the plurality of laminated reflective polarizers, linearly polarized light is converted into elliptically polarized light due to the influence by the retardation. Accordingly, the influence by retardation is smaller when the layers having large retardation are arranged at the upper portion (that is, on the light incidence side), and the layers having small retardation are arranged at the lower portion. In general, "layers having small retardation" are layers having a short reflection wavelength. The reason is that the reflection wavelength is determined by multiplying the optical path lengths of the PEN layers and the coPEN layers by two, and the film thickness becomes smaller for smaller reflection wavelengths since an equal number of layers is necessary for achieving the same polarization degree. Accordingly, for reducing the influence by retardation, it is effective to laminate the layers in order of increasing length of the reflection wavelength.

[0044]

The other factor is the influence by fine particles (dust) that are unexpectedly dispersed in the reflective polarizers or in their adhesive layers. 606 in FIG. 6 denote fine particles. Fine particles scatter light well, and, in particular, strongly scatter blue light, which has a short wavelength. As is well known, the reason that the sky looks blue is that blue light, which has a short wavelength, is scattered by fine particles and molecules in the air. Therefore, the blue reflective polarizer is disposed at the top (the light incidence side) to first reflect a polarized blue light component 612 included in incident light 611. Accordingly, the remainder of light 613 has less blue components, and accordingly is less prone to scattering.

[0045]

(Example 5)

Example 5 is a polarizing means according to the invention described in claims 7 and 8 of the present invention, and shows a more specific

embodiment of the polarizing means described in Examples 1 to 4 when used for a liquid crystal device or the like.

[0046]

First, the configuration is described. In FIG. 8, 801 denotes a light scattering member, 802 denotes a reflective polarizer that mainly reflects polarized blue light, 803 denotes a reflective polarizer that mainly reflects polarized green light, 804 denotes a reflective polarizer that mainly reflects polarized red light, 805 denotes a transparent base film, and a 806 denotes a light absorbing member. All of these elements are optically bonded to each other. For the elements 802 to 805, their counterparts described in Examples 1 to 4 were used.

[0047]

For example, an embossed plastic plate or a plastic plate in which beads are dispersed can be used as the light scattering member 801. It is also possible to mix beads into an adhesive, and directly bond them to a liquid crystal device or the like. It is also possible to use a light control plate that scatters only light incident at a specific angle. Such a light control plate is sold as LUMISTY (product name) by Sumitomo Chemical, Co., Ltd. It should be noted that "light scattering" as mentioned here refers to weak scattering at a level that does not disturb polarization. The light scattering plate is disposed for the purpose of moderately diffusing light reflected at the polarizing means, which is similar to a mirror surface.

[0048]

As the light absorbing plate 806, a black plastic sheet or black paper is bonded, or black paint is directly applied. Additionally, any desired color other than black can be used, as long as it is a relatively dark color such as blue, brown or gray. This light absorbing plate is disposed for absorbing unnecessary polarized light; however, when such polarized light is used in a semitransparent reflective liquid crystal device or the like, a translucent light absorbing plate may be used.

[0049]

(Example 6)

FIG. 9 is a diagram showing a relevant part of the structure of a liquid crystal device according to the invention described in claim 9 of the present invention. First, the configuration is described. In FIG. 9, 901 denotes a polarizing plate, 902 denotes a retardation film, 903 denotes an upper glass substrate, 904 denotes transparent electrodes, 905 denotes a liquid crystal layer, 906 denotes a sealing portion, 907 denotes a lower glass substrate, 908 denotes a light scattering member, 909 denotes a polarizing means, and 910 denotes a light absorbing member. 901 and 902, 902 and 903, 907 and 908, 908 and 909, 909 and 910 are bonded to each other with an adhesive. In addition, although the upper and lower transparent electrodes 904 are depicted as being wide apart for the purpose of clarifying the drawing, they actually face each other with a narrow gap of several μm to several ten μm kept between them. In addition to the structural elements shown in the drawing, other components such as a liquid crystal orientation film, an insulating film, spacer balls, a driver IC and a driving circuit are essential, but these are omitted from the drawing since they are not particularly necessary for describing the present invention, and may render the drawing complicated and hence make it difficult to understand.

[0050]

Next, the structural elements are described in order. The absorptive polarizing plate 901 has the function of absorbing a predetermined linearly polarized light component and transmitting the remaining polarized light components. This is a type of polarizing plate that is most commonly used at present, and produced by causing a dichroic substance, including, for example, a halogen substance such as iodine and a dye to be adsorbed in a polymer film such as polyvinyl butyral.

[0051]

The retardation film 902 may be, for example, a uniaxialy stretched film of polycarbonate resin, and used for compensating for coloration of display of an STN liquid crystal device. This is often omitted in the case of a TN liquid crystal device.

[0052]

The liquid crystal layer 905 includes an STN nematic liquid crystal composition that is twisted 180° to 270°. When the display capacity is small, it is also possible to use a TN liquid crystal composition that is twisted 90°. The twist angle is determined by the direction of the alignment process on the surfaces of the upper and lower glass substrates and the quantity of the chiral agent added to the liquid crystal.

[0053]

As the light scattering member 908, the polarizing means 909 and the light absorbing member 910, their counterparts described in Examples 1 to 5 were used.

[0054]

The liquid crystal device produced in this way has a characteristic of being at least 30% brighter than a liquid crystal device using a conventional polarizing plate and also having a high contrast. In particular, when it contains color filters to provide a color display, it has the advantage of being able to display vivid colors.

[0055]

(Example 7)

FIG. 10 is a diagram showing a relevant part of the structure of a liquid crystal device according to the invention described in claim 10 of the present invention. First, the configuration is described. In FIG. 10, 1001 denotes a polarizing plate, 1002 denotes a retardation film, 1003 denotes an upper glass substrate, 1004 denotes transparent electrodes, 1005 denotes a liquid crystal layer, 1006 denotes a sealing portion, 1007 denotes a lower glass substrate, 1008 denotes a light scattering member, 1009 denotes a

polarizing means, 1010 denotes a semi-light-absorbing member, 1011 denotes a light guide member, and a 1012 denotes a light source. 1001 and 1002, 1002 and 1003, 1007 and 1008, 1008 and 1009 are bonded to each other with an adhesive.

[0056]

Next, the structural elements are described in order. As the absorptive polarizing plate 1001, the retardation film 1002 and the liquid crystal layer 1005, their counterparts described in Example 6 were used. In addition, as the light scattering member 1008 and the polarizing means 1009, their counterparts described in Examples 1 to 5 were used.

[0057]

As the semi-light-absorbing plate 1010, it is possible to use a gray translucent film. A scattering film having a transmittance of at least 10% and at most 80%, more preferably at least 50% and at most 70% for the entire wavelength range of visible light is suitable as the gray translucent film. For example, as such a film, a light diffusive film is available under the name D202 (product name) from Tsujimoto Denki Seisakusho KK. The film has a gray appearance, and has a transmittance of 59%. It is also possible to use a light absorbing film that is partly transparent, including, for example, a black film in which pores that are so minute that cannot be seen by naked eyes are formed.

[0058]

While a LED (light-emitting diode) or a cold-cathode tube may be used as the light source 1012 in combination with the light guide plate 1011, it is also possible to use a flat light source such as an EL from the beginning. It is essential only that this backlight causes little reflection of external light. The configuration made up of the semi-light-absorbing plate 1010, the light guide plate 1011 and the light source 1012 in FIG. 10 is an example. It is also possible to adopt other configurations, including, for example, one in which the light absorbing plate is provided on the back of the light guide

plate, without providing the semi-light-absorbing plate. It is possible to achieve a simpler configuration by using an EL lamp that is designed to emit light in its transparent state or dark scattered state.

[0059]

Despite of being a semitransparent reflective liquid crystal device, the liquid crystal device produced in this way achieved a display that is at least 30% brighter than that of a reflective liquid crystal device having a brightness equivalent to that of the reflective liquid crystal device of Example 7 and using an ordinary polarizing plate. Furthermore, it achieved a display that is about twice as bright as that of a conventional semitransparent reflective liquid crystal device using an ordinary polarizing plate.

[0060]

(Example 8)

Three examples of the electronic device described in claim 10 of the present invention are described.

[0061]

The liquid crystal device according to the present invention can be used in various environments, and also is suitable for portable devices that are required to have low power consumption.

[0062]

FIG. 11(a) shows a mobile phone, in which a display portion 1102 is provided at the upper part on the front surface of a body 1101. Mobile phones are used in various environments at any place indoor or outdoor. In particular, they are often used inside automobiles, and it is very dark in automobiles at night time. Therefore, as a display device used for mobile phones, it is preferable to use a semitransparent reflective liquid crystal device that mainly provides a reflective display with low power consumption and can also provide a transmissive display using fill light, as necessary. The liquid crystal device of the present invention achieves higher brightness

and vividness for both a reflective display and a transmissive display than conventional liquid crystal devices.

[0063]

FIG. 11(b) shows a watch, in which a display portion 1104 is provided at the center of a body 1103. One important aspect of watch applications is their quality appearance. Not to mention that the liquid crystal device of the present invention is bright, and, moreover, it also develops little coloration since its properties change little depending on the wavelength of light. Furthermore, there is little change in its background color depending on the viewing angle. Accordingly, it can achieve a display with a much higher quality appearance than conventional liquid crystal devices.

[0064]

FIG. 11(c) shows a portable information device, in which a display portion 1106 and an input portion 1107 are provided on the upper side and the lower side of a body 1105, respectively. In addition, touch keys are often provided on the front surface of the display portion. Ordinary touch keys produce a large amount of surface reflection, so that the display is difficult to see. Therefore, transmissive liquid crystal devices conventionally have been used even for portable devices. However, transmissive liquid crystal devices require a large amount of power for constantly using the light source, and the battery service life is short. Since the liquid crystal device of the present invention achieves high display and vividness for both the reflective devices and the semitransparent reflective devices, it can also be used for a portable information device even in such a case. Naturally, it has low power consumption, and therefore has the advantage that the battery service life is five to ten times longer.

[0065]

[Effect of the Invention]

As set forth above, according to the present invention, it is possible to provide a bright polarizing means having a high polarization degree.

Furthermore, the object of the present invention is to provide a bright liquid crystal device with a high contrast, and an electronic device with low power consumption.

[Brief Description of the drawings]

[FIG. 1] A diagram showing a relevant part of the structure of a polarizing means according to Example 1, Example 2 and Example 3 of the present invention.

[FIG. 2] A diagram showing a relevant part of the structure of reflective polarizers used in a polarizing means according to Example 1, Example 2, Example 3 and Example 4 of the present invention.

[FIG. 3] A graph showing the polarization properties of the reflective polarizers used in the polarizing means according to Example 1 of the present invention.

[FIG. 4] A graph showing the polarization properties of the reflective polarizers used in the polarizing means according to Example 2 of the present invention.

[FIG. 5] A graph showing the polarization properties of the reflective polarizers used in the polarizing means according to Example 3 of the present invention.

[FIG. 6] A diagram showing the structure and function of the polarizing means according to Example 4 of the present invention.

[FIG. 7] A graph showing the polarization properties of the reflective polarizer used in the polarizing means according to Example 4 of the present invention.

[FIG. 8] A diagram showing a relevant part of the structure of a polarizing means according to Example 5 of the present invention.

[FIG. 9] A diagram showing a relevant part of the structure of a liquid crystal device according to Example 6 of the present invention.

[FIG. 10] A diagram showing a relevant part of the structure of a liquid

crystal device according to Example 7 of the present invention.

[FIG. 11] Diagrams showing the appearance of an electronic device according to Example 8 of the present invention: (a) a mobile phone; (b) a watch; and (c) a portable information device.

[Description of reference numerals]

101	reflective polarizer that mainly reflects polarized blue light
102	reflective polarizer that mainly reflects polarized green light
103	reflective polarizer that mainly reflects polarized red light
104	transparent base film
201	layer of material having large photoelasticity
202	layer of material having small photoelasticity
203	rectangular coordinate system, x-axis direction is stretching direction
301	reflection spectrum of 101 in reflection axis direction
302	reflection spectrum of 102 in reflection axis direction
303	reflection spectrum of 103 in reflection axis direction
311	reflection spectrum of 101 in transmission axis direction
312	reflection spectrum of 102 in transmission axis direction
313	reflection spectrum of 103 in transmission axis direction

Drawings:

Fig.1

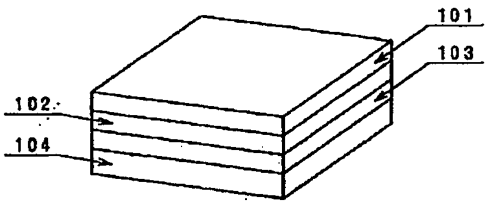

Fig.2

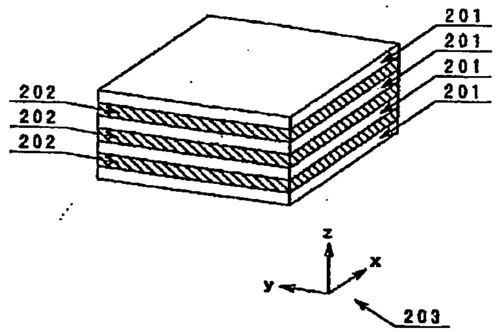

Fig. 3

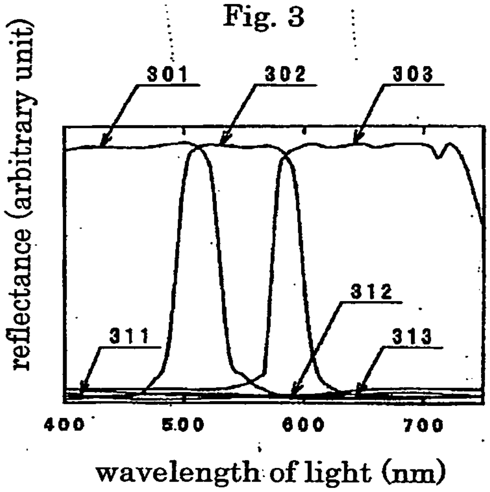

Fig. 4

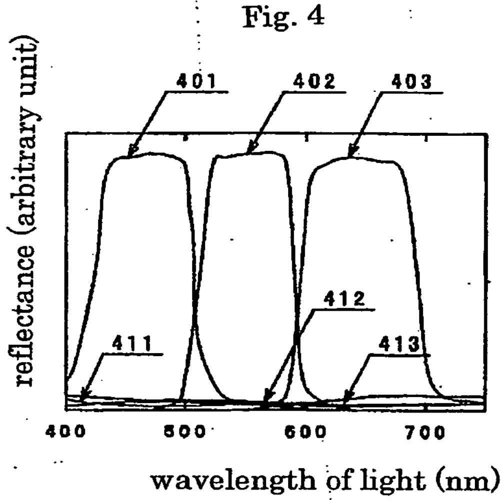

Fig. 5

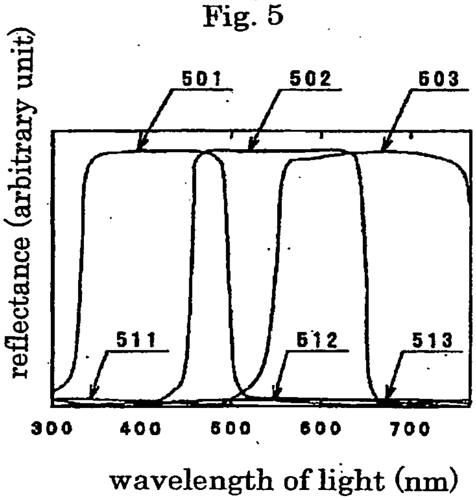

Fig. 6

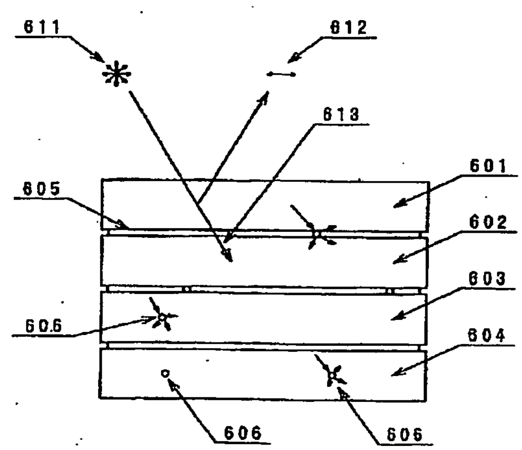

Fig.7

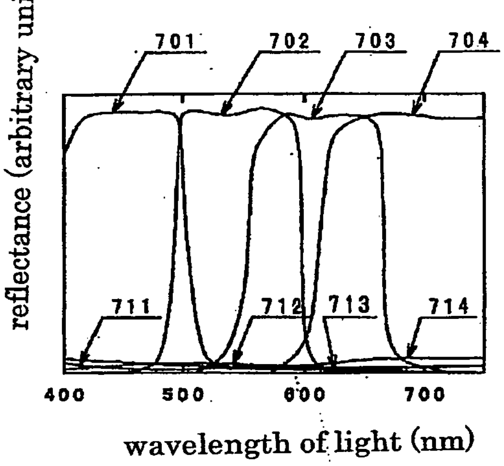

Fig.8

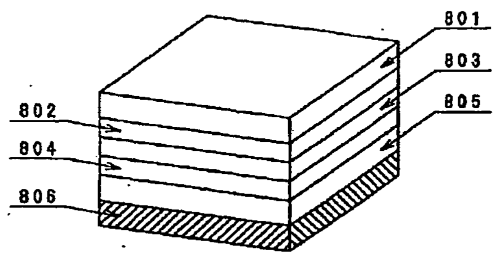

Fig.9

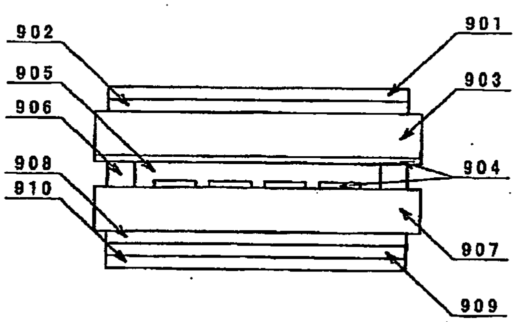

Fig.10

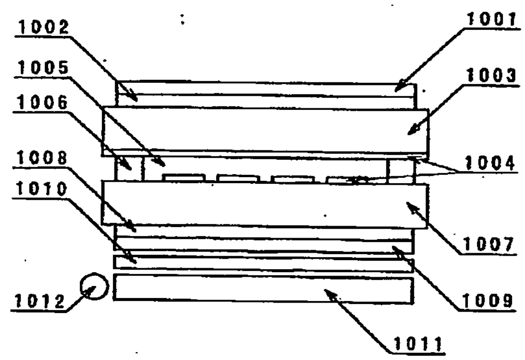

Fig. 11